

# MICHIGAN STRUCTURE INSPECTION MANUAL

## BRIDGE INSPECTION

### CHAPTER 1

#### PROGRAM REQUIREMENTS

##### 1.01 Purpose

The National Bridge Inspection Standards (NBIS) require each state transportation department to inspect, or cause to be inspected, all highway bridges located on public roads that are fully or partially located within the state's boundaries. Michigan has a decentralized bridge inspection program that delegates inspection responsibilities to the regions and local agencies throughout the state. This chapter describes the State of Michigan's Bridge Inspection Program and clarifies the responsibilities and roles of those who are involved with maintaining NBIS compliance.

##### 1.02 Laws and Regulations

The Federal Highway Bridge Inspection Program regulations were developed as a result of the Federal Aid Highway Act of 1968 that required the Secretary of Transportation to establish NBIS to ensure the safety of the traveling public. The NBIS required all public bridges on the Federal-aid highway system to have a Structure Inventory and Appraisal (SIA) conducted by 1972 and data reported to the FHWA. In 1978 NBIS was extended to include all public bridges whether or not they were located on the Federal-aid highway system. As a result of the 1983 Mianus River Bridge Failure NBIS focused attention on fracture critical bridges by establishing national inspection guidelines for steel designs without load path redundancy, additional inspector training, and new fatigue research for these types of structures. After the collapse of the Schoharie Creek Bridge in 1987 NBIS was modified based upon suggestions made in the 1987 Surface Transportation and Uniform Relocation Assistance Act. The national underwater inspection frequency interval was set at a maximum of 60 months and scour critical bridge inspections were initiated.

In addition to federal requirements, additional laws in reference to the safety inspection of bridges and culverts can be found in the Michigan Compiled Laws and are summarized as follows:

##### **Act 354 of 1925**

**254.19a Biennial inspection of bridges; plan** - The state transportation department shall institute a systematic plan of biennial inspection of all bridges under its jurisdiction.

**254.20 Posting of narrow and one-lane bridges; uniform traffic control devices** - Every bridge which has a clear 2-way roadway width of less than 19 feet, but more than 17 feet at the narrowest part thereof, shall be posted as a narrow bridge; and every bridge which has a clear 2-way roadway width, as so measured, of 17 feet or less, shall be posted as a 1-lane bridge. Such posting shall be in accordance with the manual of uniform traffic control devices adopted pursuant to section 608 of Act No. 300 of the Public Acts of 1949, being section 257.608 of the Compiled Laws of 1948.

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**254.30 Bridge and culvert; synonymous** - the words “bridge” and “culvert” as used in this act shall be considered as synonymous terms.

### **Act 300 of 1949**

**257.631 Public bridge, causeway, or viaduct; maximum speed, load, or gross weight; violation as civil infraction; assessment of civil fine; exceptions; determination of civil fine; determination of gross weight; investigation; signs; evidence** – (5) The department of transportation, county road commission, or other authority having jurisdiction of a public bridge, causeway, or viaduct may conduct an investigation of that bridge, causeway, or viaduct. If it is found after investigation that the structure cannot with safety to itself withstand vehicles traveling at the speed or carrying a load otherwise permissible under this chapter, the department, commission, or other authority shall determine and declare the maximum speed of vehicles or load which the structure can withstand, and shall cause or permit suitable signs stating that maximum speed and load limitations to be erected and maintained not more than 50 feet from each end of the structure, and also at a suitable distance from each end of the bridge to enable vehicles to take a different route.

### **1.03 Federal Highway Administration Oversight**

For more than 30 years, the Federal Highway Administration (FHWA) has annually assessed each state's bridge inspection program to evaluate compliance with NBIS as defined in 23 CFR 650 Subpart C. In 2009, the Office of Inspector General (OIG) issued an audit report in regards to the National Bridge Inspection Program: *Assessment of FHWA's Implementation of Data-Driven, Risk-Based Oversight* that summarized their review of the FHWA oversight of the National Bridge Inspection program. One of the five OIG recommendations from this audit was for FHWA to develop and implement minimum requirements for data-driven, risk-based bridge oversight during bridge engineer's annual NBIS compliance reviews. In response to the OIG recommendations and congressional direction, FHWA developed a new systematic, data-driven, risk-based oversight process for monitoring State compliance with NBIS.

The FHWA developed and implemented the current review process to evaluate a state's bridge inspection program for compliance with NBIS in 2011 as currently required by 23 U.S.C. 144(h)(4)(A). Each FHWA Division office annually assesses the State's compliance with 23 individual metrics which are directly aligned with the existing NBIS regulation. The metrics, or measures, are designed to assess the quality and performance of each State's bridge inspection program and, collectively, the national program that has been established to assure highway bridges are safe.

The risk-based assessment process followed during this annual assessment utilizes objective data, employs statistical sampling of data and inspection records, and includes defined criteria for compliance for each metric. States are notified by FHWA of any findings of noncompliance no later than December 31. In accordance with the requirements of 23 U.S.C. 144 as established by MAP-21, within 45 days of the

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FHWA notification of noncompliance, the state will correct the issue of noncompliance or submit to FHWA a Plan of Corrective Action (PCA) which outlines how noncompliant findings will be addressed. The FHWA will have 45 days for review, comment, and if appropriate accept the PCA. Final compliance determinations by FHWA are to be made no later than March 31. This annual process allows the FHWA to assess NBIS compliance by each state's bridge inspection program and implement any required penalties in a nationally consistent manner.

The description and criteria for evaluating the inspection program is described in FHWA's NBIS Oversight Program, [\*Metrics for the Oversight of the National Bridge Inspection Program\*](#). Each of the 23 metrics are annually assessed and assigned one of four compliance levels:

Compliant: Adhering to the NBIS regulation.

Substantially Compliant: Adhering to the NBIS regulation with minor deficiencies. These deficiencies do not adversely affect the overall effectiveness of the program and are isolated in nature. Documented deficiencies are provided to the State with the expectation that they will be corrected within 12 months or less, unless the deficiencies are related to issues that would most efficiently be corrected during the next inspection. A written response to the FHWA describing the expected corrective action is required.

Noncompliant: Not adhering to the NBIS regulation. Identified deficiencies may adversely affect the overall effectiveness of the program. Failure to adhere to an approved PCA is also considered noncompliance.

Conditionally Compliant: Taking corrective action in conformance With an FHWA approved PCA to achieve compliance with the NBIS. Deficiencies, if not corrected, may adversely affect the overall effectiveness of the program.

### **1.04 Organization and Responsibilities**

The NBIS defines that the state's transportation department is responsible for establishing policies and procedures, completing quality assurance and quality control, and preparation and maintenance of the bridge inventory. The transportation department is also responsible for ensuring the completion of bridge inspections, reports, load ratings, and other requirements as established by NBIS. The provisions of NBIS allow portions of these requirements to be delegated, but such delegation does not relieve the state's transportation department of any of the overall responsibility. The organization of MDOT's structure inspection program is shown in Figure 1.04.01 and described in detail later in this section.

#### **1.04.01 Bridge Inspection Program Manager**

As outlined in NBIS, the state transportation department's bridge inspection organization must have a Program Manager with specific qualifications and responsibilities. There are several levels of administration or management for the statewide bridge inspection program. The Michigan Department

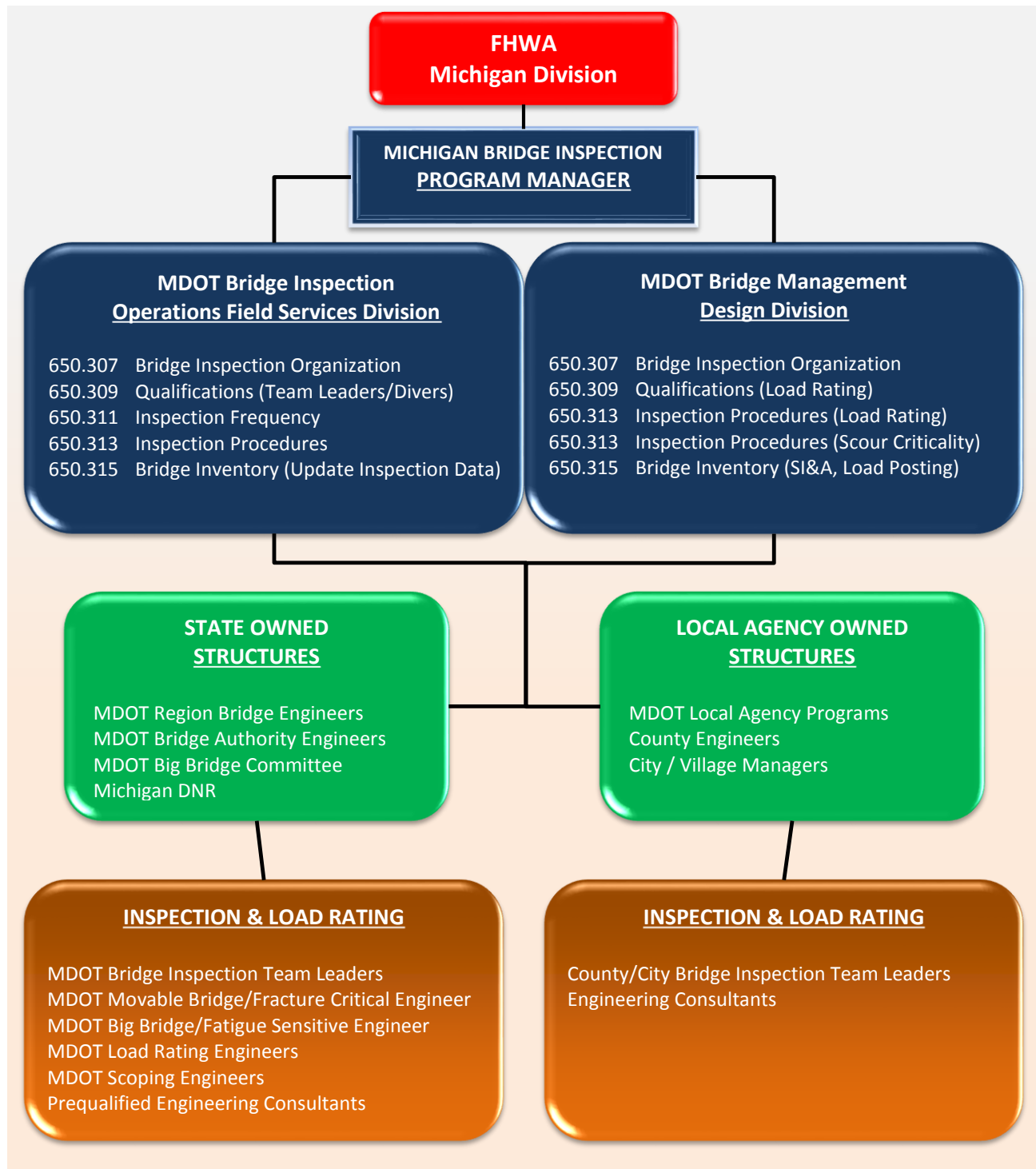
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of Transportation's (MDOT) **Operations Field Services Division** and **Design Division** share the responsibilities for maintaining compliance with NBIS. Those responsibilities include the following:

- Development of policies and procedures for bridge inspection, load rating, and management
- Development and analysis of bridge information for statewide planning needs
- Collection and management of all bridge inventory, inspection, and load rating data
- Maintenance and operation of the State's database and web application. (BMS & MiB<sup>RIDGE</sup>)
- Reporting of NBI and Element Level data to FHWA
- Completing Quality Assurance Reviews for state and local agencies
- Maintenance of a Training and Certification program for bridge inspection Team Leaders
- Coordination of statewide Scour Assessment program
- Oversight of the load rating and posting of Local Agency maintained structures
- Load Rating and Posting of State owned structures
- Operation and maintenance of Michigan's bridge inspection under-bridge inspection equipment
- NBIS compliance for all of the bridges in the State of Michigan

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*Figure 1.04.01 MDOT Bridge Inspection Organization*

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### **OPERATIONS FIELD SERVICES DIVISION, Bridge Field Services (BFS)**

MDOT's Bridge Field Services (BFS) Section functions within the Operations Field Services Division. The Bridge Field Services section serves as a statewide resource to achieve and maintain alignment on all field related bridge issues, and provides technical guidance for construction, maintenance and safety inspection of bridges and structures. Bridge Field Services also provides around-the-clock responses to structure damage and other emergency bridge situations around the state. The specific roles and responsibilities for inspection activities relating to the NBIS Program Manager that are managed by the Bridge Field Services section are described below:

FHWA NBIS Compliance and Metric Reviews: The Bridge Field Services Bridge Safety Inspection Engineer is responsible for working directly with FHWA's Michigan Division Bridge Engineer for reviewing and resolving potential NBIS compliance issues. Although the metric reviews are completed annually the coordination between MDOT and FHWA is a daily activity.

Qualifications of Personnel: Bridge Field Services is responsible for reviewing and ensuring that the program manager, team leaders, and divers performing tasks relative the NBIS meet the minimum qualifications. Bridge Field Services is also responsible for the development and implementation of the minimum amount of recurrent training for team leaders. Team Leader reviews for individuals not registered as professional engineers are evaluated thoroughly on a case-by-case basis.

Inspection Timeliness and Frequency Criteria: Bridge Field Services is responsible for developing methods and policies to ensure timely inspections. In addition, the Bridge Field Services will review compliance criteria of all agencies in accordance with FHWA and MDOT's timeliness policies. Bridge Field Services is responsible to develop, maintain and implement recommended bridge inspection frequencies in accordance with the NBIS and MDOT policies.

Bridge Inspection Procedures: Bridge Field Services is responsible for providing and maintaining inspection procedures that meet the requirements and intent of NBIS. The following chapters in this manual provide guidance and clarification of those inspection procedures.

Bridge Inspection Quality Assurance: Bridge Field Services is responsible for ensuring that quality inspection data is obtained to accurately reflect the conditions discovered during the field inspections. Quality Assurance is completed on all agencies responsible for completing inspections in accordance with NBIS.

### **BUEARU OF HIGHWAY DEVELOPMENT, Bridge Management**

MDOT's Bridge Management Section develops and maintains the bridge asset management program, ensures the completion of proper bridge load ratings, and oversees the management and monitoring of scour vulnerable structures for inventory regulated by NBIS. The specific roles and responsibilities for inspection activities relating to the NBIS Program Manager that are managed by the Bridge Management section are described below:

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Qualifications of Personnel: The Bridge Management Load Rating Engineer is responsible for ensuring that all load ratings are completed or reviewed by a registered professional engineer. In addition, the Bridge Management Load Rating Engineer is responsible for coordination and scheduling of Load Rating Workshops and Training performed throughout the State of Michigan.

Load Rating: Within the Bridge Management Section, the Bridge Load Rating Unit is responsible for making sure all bridges are load rated to verify safe load carrying capacity in accordance with NBIS. The unit is also responsible for developing and maintaining load rating guidance for assessing bridges within the state of Michigan for maximum legal loads.

Prepare and Maintain Inventory: The Bridge Management Section is responsible for maintaining the statewide database and organizing the data so it may be transmitted annually to FHWA Washington Headquarters. Throughout the year the section also reviews the data for compliance deficiencies or errors and works to resolve them with the appropriate agency or individual. The section also creates bridge records and reviews plans to ensure the structure inventory coding is accurate.

### **1.04.02 Bridge Owner**

All bridges and structures within the inventory are delegated to a Bridge Owner for responsibility and management. Subsets of bridge owners for the structures regulated by NBIS exist in the state of Michigan. Most of the structures fall under the ownership of a State Agency or Local Agency; however, there are a few private owners. State agency bridge owners include MDOT, Department of Natural Resources (DNR), Department of Management & Budget (DTMB), and several public universities. The local agency bridge owners include Counties, Cities, Villages, and Townships distributed throughout the state.

The primary role of the bridge owner is to ensure that timely and accurate bridge safety inspections and load ratings are completed for all the structures under their responsibility. Bridge owners also are responsible for ensuring that quality control activities were conducted on at least 5 percent of the inspections performed annually by the team leader.

**MDOT Statewide Bridge Owners:** Large deck, unique, and movable bridges are owned jointly by the Operations Field Services and Design Divisions. Due to the complex nature of these structures maintenance and management oversight from the central office allows for efficient diagnosis of issues that arise by a team of specialists including the Statewide Bridge Repair Crew.

**MDOT Region Bridge Owners:** All region bridge engineers serve as the bridge owner of structures meeting NBIS length requirements on state-owned routes within their jurisdiction. Every region bridge engineer is a licensed professional with the necessary training to be a qualified team leader.

**Local Agency Bridge Owners:** County, city, village, and township managers serve as the bridge owners within their designated unit of local government. Very few local agency bridge owners are professional engineers or have the required experience to meet team leader status. These

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bridge owners consult the majority of inspections and load ratings to consulting firms with qualified staff.

#### **Bridge Authorities:**

Two bridge authorities exist within the State of Michigan for managing two of the most well-known structures within the area. The Mackinac Bridge Authority preserves and maintains the longest suspension bridge in the Western Hemisphere, connecting the two peninsulas of the state. The International Bridge Authority joins northern Michigan to Ontario Canada, and is a vital asset for international trade and tourism within the region.

#### **1.04.03 Inspection Team Leader**

The Inspection Team Leader (Team Leader) is responsible for leading the structure inspection team and planning, preparing, and performing structure inspections in accordance with NBIS regulations. The Team Leader is ultimately responsible for preparing the inspection report and submitting the information to MDOT. The Team Leader shall be familiar with this manual and preferably have a background in such areas as structural engineering, structure behavior trends, bridge maintenance, and rehabilitation techniques. The Team Leader is also responsible for the general safety of the work site. Safety items can include obtaining and monitoring any required traffic control, ensuring each inspection team member complies with safety procedures, and proper use of access equipment. There must be at least one Team Leader at the structure site at all times during each type of field inspection.

#### **MDOT Statewide Inspection Team Leaders**

A collaboration of staff from the central office including Engineering Managers, Engineering Specialists, Transportation Engineers, and Transportation Maintenance Workers meet the requirements of an Inspection Team Leader. These individuals serve in multiple areas throughout MDOT and are responsible for performing a variety of activities related to the Michigan Bridge Inspection Program. Inspection team leaders who are regularly active field evaluations or providing scoping oversight include:

#### **Statewide Fracture Critical Inspector**

The Statewide Fracture Critical Inspector is responsible for performing hands-on inspection of all bridges containing fracture critical elements within the MDOT inventory. This includes annual inspections for over 76 NBI structures including movables, and additional inspections for Non-NBI structures as agency policy permits.

#### **Statewide Fatigue Sensitive Inspector**

The Statewide Fatigue Sensitive Inspector is responsible for the inspection of bridges containing AASHTO Fatigue Categories with low levels of fatigue resistance in the MDOT inventory. There are currently 183 bridges load path redundant structures that receive the special inspection at varying frequencies that do not exceed three years. In addition, the Statewide Fatigue Sensitive

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Inspector performs routine NBI inspections of MDOT owned bridges with more than 100,000 sft. of deck area.

### **Statewide Scoping Engineer**

The Statewide Scoping Engineer is responsible for scoping MDOT's 17 large deck bridges, 12 movable bridges, 7 segmental bridges, 2 cantilever deck trusses, 2 tied arch Bridges, and 1 cable stayed bridge throughout the state. The Statewide Scoping Engineer also develops bridge scoping and preservation guidelines and worksheets for use throughout the state.

### **Statewide Emergency Coordination Engineer**

The Statewide Emergency Coordination Engineer provides field review and repair expertise of damaged structural elements caused by vehicular, vessel, fire, or malfunctioning movable bridge features. Regularly scheduled duties include the design and scheduling of various repairs that must be installed prior to the next scheduled routine inspection. This repair work is conducted by the Statewide Bridge Crew which consists of a talented team of certified welders who are proficient in heat straightening, welded beam end repairs, temporary support installation, movable bridge repair and maintenance, and many other aspects that benefit the MDOT NBI inventory.

### **MDOT Region Inspection Team Leaders**

In addition to the region bridge owner, each region utilizes multiple staff that meet team leader requirements to complete the majority of routine inspections. These individuals are classified as Transportation Engineers or Transportation Maintenance Workers who have a variety of previous experience in the construction, maintenance, and/or design of bridges.

### **Consultant Inspection Team Leaders**

Consultant team leaders performing services for local agencies are often delegated responsibilities for ensuring NBIS compliance. Vendor personnel managing the contracts should review the bridge owner's inventory for data irregularities or compliance deficiencies. If any factors exist that could result in the agency being held in non-compliance the consultant team leader should notify the bridge owner and propose additional services to resolve the issues.

#### **1.04.04 Load Rating Engineer**

A load rating engineer manages all aspects of maintaining current and accurate load ratings for bridges they are responsible for. Responsibilities include reviewing inspection reports for changed conditions that warrant revisions to the load ratings on file, revising load ratings as needed, creating new load ratings for new bridges, and ensuring that the findings from load ratings are implemented. In particular, the load rating engineer ensures that the bridge inventory has current data from the load ratings and must track bridges that require posting.

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### 1.05 Qualifications

Minimum qualification requirements are defined in NBIS section 650.309 Qualifications. In addition NBIS section 650.313(g), *Quality control and quality assurance* requires the state to develop and implement the periodic bridge inspection recurrent training requirements.

Qualification requirements are assessed annually by FHWA for compliance with NBIS using the criteria specified in the following metrics:

Metric 2 – Qualifications of Personnel – <b>Program Manager</b>	NBIS 650.309(a), 650.313(g)
Metric 3 – Qualifications of Personnel – <b>Team Leader(s)</b>	NBIS 650.309(b), 650.313(g)
Metric 4 – Qualifications of Personnel – <b>Load Rating Engineer</b>	NBIS 650.309(c)
Metric 3 – Qualifications of Personnel – <b>Underwater Diver</b>	NBIS 650.309(d)

Consultants interested in service contracting with the Michigan Department of Transportation (MDOT) in the classifications of Bridge Load Rating Analysis, Bridge Safety Inspection, and Underwater Bridge Inspection must be prequalified as a prerequisite to submitting proposals for contracting. See MDOT's Consultant Prequalification Application Instructions for additional staff education and experience requirements.

#### 1.05.01 Program Manager Qualifications

The Program Manager is the individual or individuals in charge of the inspection program for a particular state who have been assigned or delegated the duties and responsibilities for bridge inspection, reporting, and inventory. The Program Manager provides overall leadership for the program and is available to the bridge owners, inspection team leaders and engineering consultants to provide guidance. The qualification requirements of a Program Manager are all of the following:

- Be a registered professional engineer or have 10 years of bridge inspection experience;
- Have successfully completed an FHWA-approved comprehensive bridge inspection training Course;
- Has completed periodic bridge inspection refresher training according the state policy

#### 1.05.02 Team Leader Qualifications

There are five (5) ways an individual can become qualified as a Team Leader which will meet the requirements of the NBIS. An individual wanting to complete bridge safety inspections in accordance with NBIS must complete an **FHWA approved comprehensive bridge inspection training course** which is typically known as the 2-week course or NHI-130055 Safety Inspection of In-Service Bridges. In addition to completing the comprehensive bridge inspection training course, individuals must meet one of the following:

1. Be a registered professional engineer;
2. Have (5) years of bridge inspection experience (Note this has to be documented);

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3. Have all of the following:
  - a. Bachelor's degree in engineering, successfully passed the Engineering and Surveying Fundamentals of Engineering exam, and
  - b. (2) years of bridge inspection experience;
4. Be certified as a Level III or IV Bridge Safety Inspector under National Certification in Engineering Technologies (NICET);
5. Have all of the following:
  - a. Associate's degree in engineering or engineering technology and,
  - b. (4) years of bridge inspection experience

Once an individual has completed the comprehensive course they must complete ongoing training that meets the state's recurrent training requirements. Michigan's policy for recurrent bridge inspection training requires successful completion of 24 hours of approved training within a 5 year period. The following instructor led, web-based, and workshop training formats are approved for recurrent training:

<b>NHI Classes - Instructor Led (ILT)</b>		
<b>NHI Class</b>	<b>Title</b>	<b>Credit (hrs)</b>
130053	Bridge Inspection Refresher	24
130078	Fracture Critical Inspection Techniques for Steel Bridges	28
130091A	Underwater Bridge Inspection	32
130054	Engineering Concepts for Bridge Inspectors	15
130110	Tunnel Inspection	32
135046	Stream Stability & Scour at Highway Bridges	20
135047	Stream Stability & Scour at Highway Bridges for Bridge Inspectors	6
135048	Countermeasure Design for Bridge Scour and Stream Instability	15
130091B	Underwater Bridge Repair, Rehabilitation, and Countermeasures	14
130099A	Bridge Inspection Nondestructive Evaluation Seminar (BINS)	13

<b>NHI Classes - Web-Based</b>		
<b>NHI Class</b>	<b>Title</b>	<b>Credit (hrs)</b>
130101	Introduction to Safety Inspection of In-Service Bridges	14
135085	Plan of Action (POA) for Scour Critical Bridges	1
135086	Stream Stability Factors and Concepts (Prerequisite)	1
135087	Scour at Highway Bridges: Concepts and Definitions (Prereq.)	1
135091	Basic Hydraulic Principles Review	1
130101A	Prerequisite Assessment for Safety Inspection of In-Service Bridges	1
130106A	Bridge Preservation Fundamentals	5
130106B	Establishing a Bridge Preservation Program	4
130106C	Communication Strategies for Bridge Preservation	3
130109A	Bridge Management Fundamentals	4
130109B	Performance-Based Management of Highway Bridges	4

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<b>Other Approved Recurrent Training</b>		
<b>Host</b>	<b>Title</b>	<b>Credit (hrs)</b>
FHWA	FHWA Introduction to Element Level Bridge Inspection (IELBI)	14
MDOT	Structure Inspection Calibration (Annually)	8
CTT/MTU	Michigan Bridge Conference Workshops (Load Rating or Inspection)	8
CTT/MTU	Load Rating Webinars	2
CTT/MTU	2012 Bridge Load Rating	12
CTT/MTU	2014 Bridge Load Rating Workshop	8
CTT/MTU	2015 Bridge Load Rating Workshop	8

NHI courses approved for recurrent training are hosted by MDOT and the American Council of Engineering Companies of Michigan (ACEC) annually. Contact MDOT's statewide training coordinator or ACEC of Michigan to verify which courses are being offered each year.

Team Leaders must meet the above qualifications and, if applicable, the recurrent training requirements at the time they complete an inspection of a structure meeting the NBIS definition of a bridge. **Qualification verification is determined by reviewing the classes or training completed within the five years prior to the month the Team Leader completed the inspection.** A team leader will be allowed a grace period of 6 months from when their qualifications have expired to complete the necessary recurrent training requirements. Structures inspected during the grace period must have 50% of the file reports reviewed and 25% of the field conditions verified. The file and field reviews must be completed by an independent team leader. The Team Leader is responsible to keep documentation on file showing the completion of the additional quality control activities during this grace period.

Team Leaders are required to provide documentation to the Bridge Owner showing they meet the requirements and qualifications for a Team Leader before performing bridge safety inspections. To insure these individuals meet the NBIS requirements, all State and Local Agency bridge owners are required to maintain a file which contains credential information for each team leader completing inspection of the structures they are responsible to maintain.

#### **1.05.03 Underwater Bridge Inspection Diver**

The individual performing the inspection of submerged elements using diving methods must complete and FHWA approved comprehensive bridge inspection course or other FHWA approved underwater bridge inspection training course. The following courses are accepted for the divers completing inspections in Michigan:

- NHI 130055 Safety Inspection of In-Service Bridges
- NHI 130091 Underwater Bridge Inspection

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There is no recurrent training requirement; however, MDOT highly recommends that inspection divers complete additional training within a 5 year period to remain knowledgeable of current inspection procedures and technologies used for completing underwater bridge inspections.

All underwater diving operations are subject to the requirements specified under 29CFR Part 1910, Commercial Diving Operations. Please see [Chapter 8](#), Underwater Inspection for additional information for those completing underwater inspections.

### **1.05.04 Load Rating Engineers**

The NBIS requires the individual charged with the overall responsibility for load rating bridges to be a registered professional engineer. As stated in the MDOT Bridge Analysis Guide, it is recommended that this individual have a minimum of 5 years of bridge design and inspection experience. The engineering skills and knowledge necessary to properly evaluate bridges may vary widely depending on the complexity of the bridge involved. The specialized skills and knowledge of other engineers may be needed to ensure proper evaluation.